What is claimed is:

1. A solid oxide fuel cell for electrochemically reacting a fuel gas with an oxidant gas to produce a DC output voltage, said solid oxide fuel cell comprising:

a layer of ceramic ion conducting electrolyte defining first and second opposing surfaces;

a conductive anode layer positioned at the first surface of said electrolyte layer; and

a conductive cathode layer positioned at the second surface of said electrolyte layer;

wherein said electrolyte layer is disposed between said anode layer and said cathode layer;

wherein said conductive cathode layer comprises a copper-substituted ferrite perovskite material.

2. The fuel cell in accordance with claim 1 wherein copper is present in the perovskite material in an amount of at least about 2 atomic percent.

3. The fuel cell in accordance with claim 1 wherein said copper is present in the copper-substituted ferrite material in an amount of at least about 5 atomic percent.

4. The fuel cell in accordance with claim 1 wherein the material is a copper-substituted lanthanum ferrite perovskite material.

5. The fuel cell in accordance with claim 4 wherein the material includes an A-site dopant selected from the group consisting of Mg, Ca, Sr, Ba, Pr, Nd, Sm and combinations thereof.

6. The fuel cell in accordance with claim 5 wherein the A-site dopant is strontium.

7. The fuel cell in accordance with claim 5 wherein the A-site dopant is present in the copper-substituted lanthanum ferrite material in an amount of from about 5 atomic percent to about 80 atomic percent and copper is present in the copper-substituted lanthanum ferrite material in an amount of from about 5 atomic percent to about 60 atomic percent.

8. The fuel cell in accordance with claim 5 wherein the copper-substituted lanthanum ferrite material further comprises at least one B-site dopant selected from the group consisting of nickel, cobalt, manganese, aluminum and chromium.

9. The fuel cell in accordance with claim 1 wherein the copper-substituted ferrite cathode exhibits a polarization resistance of from about 0.03 to about 0.50 Ωcm^2 at 650°C in air.

10. The fuel cell in accordance with claim 1 wherein the copper-substituted ferrite cathode exhibits a polarization resistance of about 0.06 Ωcm^2 at 650°C in air.

11. The fuel cell in accordance with claim 1 wherein the copper-substituted ferrite material is in contact with said electrolyte layer.

12. The fuel cell in accordance with claim 1, further comprising an interlayer between said electrolyte layer and said cathode layer.

13. The fuel cell in accordance with claim 1 wherein the copper-substituted ferrite material comprises a layer having a thickness of from about 1 to about 50 microns.

14. The fuel cell in accordance with claim 1 wherein the copper-substituted ferrite material comprises a layer having a thickness of from about 1 to about 30 microns.

15. The fuel cell in accordance with claim 1 wherein the copper-substituted ferrite material comprises essentially the entire cathode layer.

16. The fuel cell in accordance with claim 1 wherein the copper-substituted ferrite material comprises at least about 25% of said cathode layer.

17. The fuel cell in accordance with claim 1 wherein said cathode layer comprises a substantially homogenous mixture of a copper-substituted ferrite material and a finely-divided form of a second material.

18. The fuel cell in accordance with claim 1 wherein said cathode layer comprises a perovskite composition having the formula:

$$La_{1-x-x'}Sr_xA'_{x'}Cu_yB'_{y'}Fe_{1-y-y'}O_3$$

wherein x is from about 0.05 to about 0.6; y is from about 0.05 to about 0.5; x' is from 0 to about 0.5; and y' is from 0 to about 0.4.

19. The fuel cell in accordance with claim 1, further comprising at least one metallic interconnect.

20. A solid oxide fuel cell assembly for electrochemically reacting a fuel gas with a flowing oxidant gas to produce a DC output voltage, said assembly comprising a plurality of integral fuel cell units, each unit comprising a layer of ceramic ion conducting electrolyte disposed between a conductive anode layer and a conductive cathode layer;

wherein the cathode layer of at least one of said fuel cells comprises a copper-substituted ferrite composition.

21. The fuel cell assembly in accordance with claim 20 wherein copper is present in the composition in an amount of at least about 2 atomic percent.

22. The fuel cell assembly in accordance with claim 20 wherein said copper is present in the copper-substituted ferrite composition in an amount of at least about 5 atomic percent.

23. The fuel cell assembly in accordance with claim 20 wherein the composition is a copper-substituted lanthanum ferrite perovskite material.

24. The fuel cell assembly in accordance with claim 23 wherein the composition includes an A-site dopant selected from the group consisting of Mg, Ca, Sr, Ba, Pr, Nd, Sm and combinations thereof.

25. The fuel cell assembly in accordance with claim 24 wherein the A-site dopant is strontium.

26. The fuel cell assembly in accordance with claim 24 wherein the A-site dopant is present in the copper-substituted lanthanum ferrite composition in an amount of from about 5 atomic percent to about 80 atomic percent and copper is present in the copper-substituted lanthanum ferrite composition in an amount of from about 5 atomic percent to about 60 atomic percent.

27. The fuel cell assembly in accordance with claim 24 wherein the copper-substituted lanthanum ferrite composition further comprises at least one B-site dopant selected from the group consisting of nickel, cobalt, manganese, aluminum, and chromium.

28. The fuel cell assembly in accordance with claim 20 wherein the copper-substituted ferrite cathode exhibits a polarization resistance of from about 0.03 to about 0.50 Ωcm^2 at 650°C in air.

29. The fuel cell assembly in accordance with claim 20 wherein the copper-substituted ferrite cathode exhibits a polarization resistance of about 0.06 Ωcm^2 at 650°C in air.

30. The fuel cell assembly in accordance with claim 20 wherein the copper-substituted ferrite composition is in contact with said electrolyte layer.

31. The fuel cell assembly in accordance with claim 20, further comprising an interlayer between said electrolyte layer and said cathode layer.

32. The fuel cell assembly in accordance with claim 20 wherein the copper-substituted ferrite composition comprises a layer having a thickness of from about 1 to about 50 microns.

33. The fuel cell assembly in accordance with claim 20 wherein the copper-substituted ferrite composition comprises a layer having a thickness of from about 1 to about 30 microns.

34. The fuel cell assembly in accordance with claim 20 wherein the copper-substituted ferrite composition comprises essentially the entire cathode layer.

35. The fuel cell assembly in accordance with claim 20 wherein the copper-substituted ferrite composition comprises at least about 25% of said cathode layer.

36. The fuel cell assembly in accordance with claim 20 wherein said cathode layer comprises a substantially homogenous mixture of a copper-substituted ferrite composition and a finely-divided form of a second material.

37. The fuel cell assembly in accordance with claim 20 wherein said cathode layer comprises a perovskite composition having the formula:

$$La_{1-x-x'}Sr_xA'_{x'}Cu_yB'_{y'}Fe_{1-y-y'}O_3$$

wherein x is from about 0.05 to about 0.6; y is from about 0.05 to about 0.5; x' is from 0 to about 0.5; and y' is from 0 to about 0.4.

38. The fuel cell assembly in accordance with claim 20, further comprising:

a system for passing a gaseous fuel in contact with said anode layers and passing an oxidizing gas in contact with said cathode layers; and

a system for utilizing electrical energy produced by said fuel cells.

39. The fuel cell assembly in accordance with claim 20, further comprising at least one metallic interconnect.

40. A cathode for a solid oxide fuel cell, the cathode comprising a copper-substituted ferrite perovskite material.

41. The cathode in accordance with claim 40 wherein copper is present in the perovskite material in an amount of at least about 2 atomic percent.

42. The cathode in accordance with claim 40 wherein copper is present in the perovskite in an amount of at least about 5 atomic percent.

43. The cathode in accordance with claim 40 wherein the material is a copper-substituted lanthanum ferrite perovskite material.

44. The cathode in accordance with claim 43 wherein the material includes an A-site dopant selected from the group consisting of Mg, Ca, Sr, Ba, Pr, Nd, Sm and combinations thereof.

45. The cathode in accordance with claim 44 wherein the A-site dopant is strontium.

46. The cathode in accordance with claim 44 wherein the A-site dopant is present in the copper-substituted lanthanum ferrite material in an amount of from about 5 atomic percent to about 80 atomic percent and copper is present in the copper-substituted

lanthanum ferrite material in an amount of from about 5 atomic percent to about 60 atomic percent.

47. The cathode in accordance with claim 44 wherein the copper-substituted lanthanum ferrite material further comprises at least one B-site dopant selected from the group consisting of nickel, cobalt, manganese, aluminum, and chromium.

48. The cathode in accordance with claim 40 wherein the copper-substituted ferrite cathode exhibits a polarization resistance of from about 0.03 to about 0.50 Ωcm^2 at 650°C in air.

49. The cathode in accordance with claim 40 wherein the copper-substituted ferrite cathode exhibits a polarization resistance of about 0.06 Ωcm^2 at 650°C in air.

50. The cathode in accordance with claim 40 wherein the copper-substituted ferrite material is in contact with an electrolyte layer.

51. The cathode in accordance with claim 50, further comprising an interlayer between said electrolyte layer and said cathode layer.

52. The cathode in accordance with claim 40 wherein the copper-substituted ferrite material comprises a layer having a thickness of from about 1 to about 50 microns.

53. The cathode in accordance with claim 40 wherein the copper-substituted ferrite material comprises a layer having a thickness of from about 1 to about 30 microns.

54. The cathode in accordance with claim 40 wherein the copper-substituted ferrite material comprises essentially the entire cathode.

55. The cathode in accordance with claim 40 wherein the copper-substituted ferrite material comprises at least about 25% of said cathode.

56. The cathode in accordance with claim 40 wherein said cathode comprises a substantially homogenous mixture of a copper-substituted ferrite material and a finely-divided form of a second material.

57. The cathode in accordance with claim 40 wherein said cathode comprises a perovskite composition having the formula:

$$La_{1-x-x'}\,Sr_xA'_{x'}Cu_yB'_{y'}Fe_{1-y-y'}\,O_3$$

wherein x is from about 0.05 to about 0.6; y is from about 0.05 to about 0.5; x' is from 0 to about 0.5; and y' is from 0 to about 0.4.

58. An oxygen reduction electrode for an electrochemical device, the electrode comprising a copper-substituted ferrite perovskite material.

59. The electrode in accordance with claim 58 wherein copper is present in the copper-substituted ferrite material in an amount of at least about 2 atomic percent.

60. The electrode in accordance with claim 58 wherein the electrochemical device is selected from the group consisting of a solid oxide fuel cell, an electrolyzer, an electrochemical pump and an electrochemical sensor.

61. The electrode in accordance with claim 58 wherein copper is present in the perovskite material in an amount of at least about 2 atomic percent.

62. The electrode in accordance with claim 58 wherein said copper is present in the copper-substituted ferrite material in an amount of at least about 5 atomic percent.

63. The electrode in accordance with claim 58 wherein the material is a copper-substituted lanthanum ferrite perovskite material.

64. The electrode in accordance with claim 63 wherein the material includes an A-site dopant selected from the group consisting of Mg, Ca, Sr, Ba, Pr, Nd, Sm and combinations thereof.

65. The electrode in accordance with claim 64 wherein the A-site dopant is strontium.

66. The electrode in accordance with claim 64 wherein the A-site dopant is present in the copper-substituted lanthanum ferrite material in an amount of from about 5 atomic percent to about 80 atomic percent and copper is present in the copper-substituted lanthanum ferrite material in an amount of from about 5 atomic percent to about 60 atomic percent.

67. The electrode in accordance with claim 64 wherein the copper-substituted lanthanum ferrite material further comprises at least one B-site dopant selected from the group consisting of nickel, cobalt, manganese, aluminum and chromium.

68. The electrode in accordance with claim 58 wherein the copper-substituted ferrite electrode exhibits a polarization resistance of from about 0.03 to about 0.50 Ωcm^2 at 650°C in air.

69. The electrode in accordance with claim 58 wherein the copper-substituted ferrite electrode exhibits a polarization resistance of about 0.06 Ωcm^2 at 650°C in air.

70. The electrode in accordance with claim 58 wherein the copper-substituted ferrite material comprises a layer having a thickness of from about 1 to about 50 microns.

71. The electrode in accordance with claim 58 wherein the copper-substituted ferrite material comprises essentially the entire electrode.

72. The electrode in accordance with claim 58 wherein the copper-substituted ferrite material comprises at least about 25% of said electrode.

73. The electrode in accordance with claim 58 wherein said electrode comprises a substantially homogenous mixture of a copper-substituted ferrite material and a finely-divided form of a second material.

74. The electrode in accordance with claim 58 wherein said electrode comprises a perovskite composition having the formula:

$$La_{1-x-x'}Sr_xA'_{x'}Cu_yB'_{y'}Fe_{1-y-y'}O_3$$

wherein x is from about 0.05 to about 0.6; y is from about 0.05 to about 0.5; x' is from 0 to about 0.5; and y' is from 0 to about 0.4.

75. A method for producing electrical energy, comprising:

providing a solid oxide fuel cell, the solid oxide fuel cell including a layer of ceramic ion conducting electrolyte defining first and second opposing surfaces; a conductive anode layer positioned at the first surface of said electrolyte layer; and a conductive cathode layer positioned at the second surface of said electrolyte layer; wherein said electrolyte layer is disposed between said anode layer and said cathode layer; wherein said conductive cathode layer comprises a copper-substituted ferrite material;

causing air or other oxidizing gas to flow in contact with the cathode layer; and

causing a fuel gas to flow in contact with the anode layer to provide electrical energy.

76. The method in accordance with claim 75 wherein copper is present in the copper-substituted lanthanum ferrite material in an amount of at least about 2 atomic percent.

77. The method in accordance with claim 75, further comprising operating the fuel cell at a temperature of no greater than about 750°C.

78. The method in accordance with claim 75 wherein the solid oxide fuel cell further comprises at least one metallic interconnect.

79. A method for making an oxygen reduction electrode for an electrochemical device comprising:

providing a copper-substituted ferrite perovskite material; and

forming the copper-substituted ferrite perovskite material into an electrode for an electrochemical device.

80. The method in accordance with claim 79 wherein copper is present in the copper-substituted ferrite material in an amount of at least about 2 atomic percent.

81. The method in accordance with claim 79 wherein the electrochemical device is selected from the group consisting of a solid oxide fuel cell, an electrolyzer, an electrochemical pump and an electrochemical sensor.

82. The method in accordance with claim 79 wherein copper is present in the perovskite material in an amount of at least about 2 atomic percent.

83. The method in accordance with claim 79 wherein said copper is present in the copper-substituted ferrite material in an amount of at least about 5 atomic percent.

84. The method in accordance with claim 79 wherein the material is a copper-substituted lanthanum ferrite perovskite material.

85. The method in accordance with claim 84 wherein the material includes an A-site dopant selected from the group consisting of Mg, Ca, Sr, Ba, Pr, Nd, Sm and combinations thereof.

86. The method in accordance with claim 85 wherein the A-site dopant is strontium.

87. The method in accordance with claim 85 wherein the A-site dopant is present in the copper-substituted lanthanum ferrite material in an amount of from about 5 atomic percent to about 80 atomic percent and copper is present in the copper-substituted

lanthanum ferrite material in an amount of from about 5 atomic percent to about 60 atomic percent.

88. The method in accordance with claim 85 wherein the copper-substituted lanthanum ferrite material further comprises at least one B-site dopant selected from the group consisting of nickel, cobalt, manganese, aluminum and chromium.

89. The method in accordance with claim 79 wherein the copper-substituted ferrite electrode exhibits a polarization resistance of from about 0.03 to about 0.50 Ωcm^2 at 650°C in air.

90. The method in accordance with claim 79 wherein the copper-substituted ferrite electrode exhibits a polarization resistance of about 0.06 Ωcm^2 at 650°C in air.

91. The method in accordance with claim 79 wherein the electrode comprises a layer having a thickness of from about 1 to about 50 microns.

92. The method in accordance with claim 79 wherein the copper-substituted ferrite material comprises essentially the entire electrode.

93. The method in accordance with claim 79 wherein the copper-substituted ferrite material comprises at least about 25% of said electrode.

94. The method in accordance with claim 79 wherein said electrode comprises a substantially homogenous mixture of a copper-substituted ferrite material and a finely-divided form of a second material.

95. The method in accordance with claim 79 wherein said electrode comprises a perovskite composition having the formula:

$$La_{1-x-x'}Sr_xA'_{x'}Cu_yB'_{y'}Fe_{1-y-y'}O_3$$

wherein x is from about 0.05 to about 0.6; y is from about 0.05 to about 0.5; x' is from 0 to about 0.5; and y' is from 0 to about 0.4.